Agile Behavior Of Business Intelligence Systems: An Empirical Study On The Impact Of In-Memory Technology

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AGILE BEHAVIOR OF BUSINESS INTELLIGENCE SYSTEMS: AN EMPIRICAL STUDY ON THE IMPACT OF IN-MEMORY TECHNOLOGY

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Abstract

To achieve strategic advantage in increasingly turbulent environments, it is vital for organizations to draw faster conclusions out of changing circumstances. As most decisions today are based on data collected by Information Systems, the IS itself must become more adaptable. This is particularly challenging in the domain of Business Intelligence since the underlying architectural approach of enterprise-wide decision support systems is not built upon agility, but on reliability and robustness over a period of time. This paper aims to investigate whether new technological trends (e.g. In-Memory Databases) or agile process methods (e.g. Extreme Programming) can help achieving more agility in BI and therefore corporate strategy. The presented research-in-progress paper explains the underlying assumptions in detail, outlines the background research on the topic and proposes a hypotheses model as well as research approach as the center of this study. It concludes by providing an outlook of expected results and future research.

Keywords: Business Intelligence, Agility, In-Memory Databases, Hypotheses Model, Process Methods.
1 Introduction and Motivation

In order to be sustainably successful in the future, organizations must flexibly adjust to uncertain and changing market situations, like increasingly global integration or financial and political crises (Wensley and van Stijn, 2007; Gandossy, 2003). Since Information Systems (IS) are part of almost all business operations and maneuver in sync with a company’s business strategy, quick adaptation in IS is crucial to support the company’s competitiveness (e.g. Sambamurthy et al., 2003; Rockart et al., 1996; Galliers, 2007). However, achieving agility in IS and especially Business Intelligence (BI) as a distinct class of dispositive IS is not a trivial endeavor (Moss, 2009). The vision for a BI system has traditionally been a single, central repository of data that supports operational and analytical functions for the entire organization. Hence, the tasks of reporting and consolidation typically have rigid requirements in terms of robustness, reliability and non-volatility to the data provided by the BI system; respectively its underlying concept of the Data Warehouse (DW) (Inmon, 1996).

In order to make BI applicable to volatile environments and requirements, the usage of agile process or management methods (e.g. Scrum (Schwaber, 1997), Extreme Programming (XP) (Beck, 2000) or BI-adapted versions (Hughes, 2008; Collier, 2011)) have been topic of recent discussions (e.g. Zimmer et al., 2012). Yet, agile methods focus on the process of creating or changing a BI system. In addition to applying agile methods to the developing process, the BI system itself must become more adaptable to meet changing business requirements. This may be achieved by different architectural approaches (Caruso, 2011), adequate organizational structures and processes (Zimmer et al., 2012) or applying new and innovative technologies such as in-memory (IM) (Evelson, 2011). Current research activities in the area of in-memory databases (IMDB) achieved promising results (Plattner, 2009; Plattner and Zeier, 2011; Schaffner et al., 2009). Therefore, the aim of this research is to investigate if and how the usage of IMDB affects the adaptability of BI and whether there are dependencies to agile process or (project) management methods. To achieve this goal, we are conducting a quantitative study using a questionnaire-based survey to answer the following research questions:

- Does the usage of in-memory based technology result in more agile BI?
- Do requirements of agility conflict with the common BI approach, i.e. Data Warehouse (DW)?
- What are the implications for BI initiatives in agile environments?
- Does the application of agile process methods like Scrum or XP result in more agile BI?

In this paper, we first examine the value of agility in the context of IS and BI. Afterwards, we introduce a framework for understanding BI agility. The behavior of current BI within the DW approach is explained next. The third section introduces our research model and describes our approach in detail. In the last section, tentative conclusions are given, the intended contribution is described and an outlook to future research opportunities is provided.

2 Research Background

2.1 The strategic value of agility in IS and BI

The concept of agility has been established in practice and discussed in literature for decades and is not solely limited to IS. In business, the concept originated in the field of manufacturing (Pankaj et al., 2009). Researchers have provided a wide range of definitions (cf. appendix in Pankaj et al., 2009) - often with deficiencies in the academic approach to arrive at these definitions (Pankaj et al., 2009). In contrast, Conboy and Fitzgerald (Conboy and Fitzgerald, 2004) conducted a cross-discipline literature review to derive a holistic definition of agility. In particular, they investigated the underlying concepts of agility, i.e. flexibility and leanness (Conboy, 2009). They define agility as “the continual readiness of an entity to rapidly or inherently, proactively or reactively, embrace change, through high quality, simplistic, economical components and relationships with its environment” (Conboy and Fitzgerald, 2004). The concept of agility in the context of BI can be framed as described by Knabke and Olbrich (2013). In a structured literature review, the individual components of existing definitions on agility in
the field of IS in general and for BI systems in particular were analyzed. As a result, similar constructs of agility could be grouped, as briefly explained below:

**Change Behavior** A central construct of agility is the behavior with regard to change. Thus, a system can behave reactively, proactively, create or even learn from change.

**Perceived Customer Value** This concept highlights the importance of quality, simplicity and economy as important factors for agility.

**Time** A crucial criterion for agile BI is the ability to adapt to changing environments over time. This can either happen in a continuous process or “ad-hoc”. The actual physical length of time is dependent on the context of the IS and may differ for strategic, tactical and operational IS.

**Process** An agile IS should be able to sense, analyze and respond to a change. In addition to process improvements, it should support methodologies and organizational structures so that it is able to quickly respond to changing requirements.

**Model** The model incorporates the architecture and its layers of BI. Agile BI may even require a new architectural approach that is reusable, reconfigurable and scalable.

**Environment** The need for change often arises outside the IS. But the environment of BI can be interpreted in multiple ways, e.g. as business processes, people, customers, clients, organizations or formalities.

**Approach** Agile development or project management tries to improve the development of software.

**Technology** The obvious performance and technical impacts due to in-memory storage are not the only reasons for interest in deeper investigation of IMDBs. Reducing memory consumption, solving the important “time-variant” (Inmon, 1996) but not trivial topic of capturing history changes (Chamoni and Stock, 1999) are just a few demonstration examples. In addition, in-memory BI may soften the common layered BI architecture and positively affect the agility of BI architectures (Knabke and Olbrich, 2011).

### 2.2 The behavior of BI systems

BI systems are a broad category of IS that support decision makers through business analyses on the basis of internal and external data (Chung et al., 2005; Watson and Wixom, 2007; Abbasi and Chen, 2008). Most multidimensional BI systems utilize the DW approach (Watson and Wixom, 2007; Rifaie et al., 2008) in order to systematically extract, harmonize and provide data. A DW is built to fulfill fundamental requirements (Inmon, 1996), which are described below.

**Integration** within a DW is accomplished by passing the data from the organization’s operational applications to the DW and making the data consistent. This allows for a single point of truth in terms of key performance indicators and data representation of the enterprise.

**Subject-Orirection** BI elements are organized according to the subject areas of the corporation. Objects related from a business perspective are linked together.

**Time-Variance** A DW displays characteristics and key figures over a longer period of time. In contrast to an operational system, structures in a DW always contain a connection to time. Changes are tracked and recorded so that reports can be produced showing changes over time.

**Non-Volatility** Data loaded into the DW is never updated, over-written or deleted. It stays persistently, is static and read-only.

There is enormous potential for DW/BI systems to contribute to corporate success. Therefore, many organizations have launched BI initiatives with the intention to implement or improve these systems (Wixom and Watson, 2010). Yet, BI implementation projects are expensive, time-consuming and risky undertakings (Wixom and Watson, 2001; Gartner, 2009). In short, it seems that the underlying characteristics of DW/BI aim towards robustness and reliability, which seem to contradict the
requirements of today’s agile environments. Since neither the strategic value of IS agility nor the potential of BI is arguable, the question is raised whether and how both can be fulfilled.

3 The Impact of IMDB on BI Agility

3.1 Research model

To identify the impact of BI characteristics on the agility of BI, we propose a hypotheses model as depicted in Figure 1. Each characteristic of DW/BI (Inmon, 1996) may influence BI in terms of agility (Knabke and Olbrich, 2013). As our goal is to achieve objective study results, we will not exclude any hypothesis in a priori. Thus, we start with a potential hypotheses space of 20 (4x5) as a baseline model. To omit research bias, we will also not originate positive or negative influence within the hypotheses. One of these hypotheses that do not consider a moderating variable is e.g. 

\[ \text{Hypothesis x: Integration affects the agility of BI in terms of model.} \]

We assume that IMDB positively affects the agility of BI and there are several indications for this assumption (Evelson, 2011; Plattner, 2009; Plattner and Zeier, 2011). Nevertheless, to our knowledge, this potential positive impact has not been investigated as yet. The crucial question of our research is whether IMDB is still advantageous given the underlying requirements of BI. Thus, the central construct of our research model (see Figure 1) is IMDB as a potential technology enabler for agile BI compared to traditional disk based database system (DBDB). Furthermore, we assume that IMDB positively support the DW/BI characteristics (Inmon, 1996) to achieve more agile BI. Another important aspect is the influence of the BI creation process, i.e. approach. Technology and approach are integrated as moderators in our research model. Taking the moderators into account, we achieve 80 (4x5x4) potential hypotheses, for example 

\[ \text{Hypothesis x:1: The impact of integration on the agility of BI in terms of model is influenced positively by IMDB.} \]

![Figure 1. Research model](image)

3.2 Research approach

The aim of our research is to identify relations between basic characteristics of BI (independent variable) as described by Inmon (1996) and their impact on BI agility (depending variable). The influences of technology (IMDB vs. DBDB) and approach (traditional vs. agile) are central aspects of
the study and designed as moderating variables. The research approach is a quantitative one using statistics to identify correlations between characteristics and agility of BI. One appropriate and acknowledged method for causal relations in the field of IS is a structural equation model (Gefen et al., 2000) with the correct usage of partial least squares (PLS) (Chin, 1998; Rönkkö et al., 2012). The suggested approach has several advantages. First, it will eliminate irrelevant hypotheses in an objective manner by using correlation analysis. Thus, in subsequent research such as in-depth case studies, we do not have to consider the complete hypotheses space (4x5x4=80), but can focus on the relevant ones. Moreover, this approach will show positive and negative impacts of these hypotheses. Our assumption is that in-memory technology positively affects the agility of BI in comparison with traditional stored database management systems. We assume that this holds true for all criteria of agility or at least that no negative impacts exist. In contrast to the used IMDB technology, we assume that the applied process method has no sustainable positive effect on the agility of BI. It may even be negative in certain environments.

The research will be executed with the data collection technique of a structured, self-administered survey (Leeuw et al., 2008). The questionnaire will be web and paper based depending on the participant’s preference. This approach is better suited to analyze a wide variety of BI systems behavior compared to field experiments or separate expert interviews on their actual systems because surveys usually achieve bigger sample sizes. Field experiments or expert interviews could only focus on their actual systems and would narrow the size of the study. In addition, the participants’ responses can be aggregated in a standardized manner and used for quantitative analysis (Bhattacherjee, 2012). The questionnaire was developed following the rules of Dillman (Dillman et al., 2009). To date, a group of researchers in our institute have scrutinized our questionnaire to ensure high quality and quantity of questions and responses. The reworked questionnaire focuses on each part of the research model separately (i.e. dependent, independent and moderating variable) and includes control questions (Bhattacherjee, 2012). The answers consist of non-dichotomous (Likert scales) or dichotomous (yes/no) rating scales. The questionnaire will be sent out to employees of a BI consulting group and experts (scientists and practitioners) at The Data Warehouse Institute (TDWI). This ensures industry-spanning responses from BI practitioners, software consultants as well as scientists. Later, candidates from a variety of company sizes will be surveyed to further analyze interesting findings. The chosen survey candidates will have senior or management positions with significant work experience in the area of BI.

4 Tentative Conclusion, Intended Contribution and Outlook

Our overall research goal is to contribute to the field of agility in the context of BI. We consider this discussion as highly valuable, since we assume that the underlying requirements of BI (Inmon, 1996) contradict the agility framework introduced in section 2.1 and thus, the agility of BI in general. Similar requirements of robustness may be an obstacle for the agility of enterprise systems, too, which makes BI systems a viable example of the IS research on agility in general. In order to adjust to turbulent environments, the discussion in BI focuses mainly on agile process methods (e.g. Scrum or XP) and scalability (currently addressed in “Big Data” discussion) rather than its (DW-) architecture. While these might be viable approaches to adjust to changing environments given the current procedures, we doubt that this is suitable to (pro-) actively steer the future. We are interested to find out if technological changes like IMDB influence the overall readiness for change and how they impact current approaches.

We started our research-in-progress by reviewing the literature on IS and BI agility. This provides the reader a holistic understanding of BI agility. Based on this understanding of agility, we proposed a model of hypotheses that we plan to prove/disprove with the technique of a survey-based questionnaire. The answers will be evaluated using quantitative methods, which limits subjectivity as the hypotheses are derived by objective statistics. We expect two main results from the surveys. First, we try to find out whether or not IMDB can bridge the gap between rigid DW/BI characteristics and
requirements for agility. Understanding these relations in detail should be a step forward towards agile BI systems and even agile IS. Practitioners will benefit first-hand from these concepts since decision support by BI systems will move away from historic data to actively steer the future using real-time data. In practice, this will affect the way BI/IS supports the enterprise organizations decision process as well as the corporate strategies. As the study surveys experiences with IMDB systems in a broader size as field experiments could, it directly impacts practitioners that plan to utilize IMDB-based BI. The detailed investigation of the most relevant and promising hypotheses in separate case studies would be another opportunity for future research. We are happy to present detailed results next year when the research is complete.

References


